COMIREX-D-15.2/5

9 November 1967

MEMORANDUM FOR: Committee on Imagery Requirements and Exploitation

SUBJECT : Mapping Accuracy and Artillery Effectiveness

The attached paper setting forth the rationale supporting the Army's requirements for accurate large-scale (1:50,000) topographic maps has been furnished to the Chairman, COMIREX, by Mr. Charles L. Poor, Deputy Assistant Secretary of the Army (R&D). It is forwarded for the information of COMIREX members and members of the Mapping, Charting, and Geodesy Working Group.

25X1

[redacted]
Executive Secretary
Committee on Imagery Requirements and Exploitation

Attachment

25X1

Copies 2, 3	State TCO
4	DIA TCO [redacted]
5-8	DIA TCO
9	DIA TCO (Chairman, MCGWG)
10	DIA MCGWG Member
11, 12	OACSI TCO
13, 14	OACSI MCGWG Member
15, 16	ONI TCO
17, 18	ONI MCGWG Member
19-22	AFNIN TCO
23, 24	AFNIN MCGWG Member
25, 26	NSA TCO
27, 28	NSA MCGWG Member
29, 30, 31	SAFSS TCO

Army review(s) completed.

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DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
WASHINGTON, D.C. 20310

3 November 1967

Mapping Accuracy and Artillery Effectiveness

The Army, regarded as a weapons system, consists of people, means for transport and communication, and firepower. To be effective the Army must know, in considerable detail, the nature of the terrain over which it operates. Topographic maps constitute the principal means of providing this knowledge to the field commander.

While maps are important in planning operations and to answer the questions "Where am I?", and "What is over the hill?", highly accurate maps are required primarily because of their importance as a component in the firepower system of the Army. It is the purpose of this memorandum to illustrate the role of maps in the artillery system and to assess the value that should be assigned to map accuracy.

During the past decade, a great deal of attention has been paid to improving the effectiveness of artillery shells to improving the reliability and accuracy of artillery systems, and to developing computers, communication gear, and meteorological measurement techniques which will permit accurate coordination of fires from dispersed artillery pieces. Thus, we should be able to bring upon targets, as they are identified, sufficient artillery fire to neutralize those targets efficiently. At the same time, much effort has been given to the development of target acquisition and surveillance means to permit detection of enemy movements and identification of useful targets as they develop in the course of the battle.

The utility of all of these developments depends critically on the availability of accurate maps. Without them, the sophistication of other elements of the overall weapons system becomes virtually useless, and the artilleryman is reduced to using his weapons as a means of locating the target with respect to the firing pieces. It was because of the lack of precision in maps, the lack of accurate, rapid, range finding equipment, and the lack of computer facilities to solve the ballistic problem in the field that the technique of "forward observer-controlled" fire was developed. This technique

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demands the firing of a few "spotting rounds" into the target area under the eyes of a forward observer simply to determine the location of the target, so that multiple tube volleys may be delivered in what is called "time-on-target" fire.

The effectiveness of time-on-target fire against personnel depends critically on whether or not the enemy in the target area has warning. Calculations by the Ballistic Research Laboratories, based on experimental data for various target postures and various kinds of artillery shell, indicated that, in general, the vulnerability of a target may be reduced approximately ten (10) times if the target is warned of incoming fire and the people in the target area have time to seek shelter in foxholes. The system of using forward observers to control fire provides that warning of necessity. If the available maps are not sufficiently good to permit exploitation of the fire control system to permit precise delivery of effective first rounds against targets in known locations, then the ten-fold advantage of surprise is denied us.

Accurate maps also have a role in the control of artillery fires where surprise cannot be exploited. In many situations it is important to deliver artillery fire on enemy units close to our own troops. Under such circumstances, friendly units under attack will call for artillery fire to be delivered as close to their positions as possible, even to the extent of risking friendly casualties to assure effectiveness against the attacking enemy. The closeness with which such fires can be called down depends not only on the accuracy of the artillery system, but also on the accuracy with which the relative positions of the artillery piece and the friendly unit can be determined. In any case, a few tens of meters are significant in such operations.

It should now be clear that an accurate topographic map is essential if our artillery fire system is to function effectively. In view of the importance of topographic maps, the Army has given great attention to accuracy requirements in order to avoid asking for maps better than it really needs and at the same time to avoid accepting significant degradation in its combat potential through maps which cannot do the job. Translated into units useful for cartographers, the Army requirements for accuracy of large scale (1:50,000) maps are as follows:

Mapping Accuracy and Artillery Effectiveness (Cont'd)

Horizontal target location accuracy: 25m (CEP) or ± 45m (90% assurance)

Vertical target location accuracy: ± 10m (90% assurance)

The degradation of weapons effectiveness which would result from relaxing these requirements has been analyzed for tube artillery and missile systems planned for combat use through 1975 and beyond. The following examples, for the 105mm and 155mm Howitzers, are illustrative of the results of these analyses and have been selected because these weapons are and will continue to be most frequently used for direct support of ground combat operations.

When 105mm Howitzers are used against enemy troops at ranges of a few kilometers, the number of rounds to produce a specified level of casualties increases by approximately 25% if the current requirement for ± 10-meter vertical target location accuracy is relaxed to ± 40-meters. Ammunition for Army 105mm Howitzers in South Vietnam is presently issued at a rate of approximately 20 rounds per tube per day, resulting in a 105mm ammunition cost of approximately $150 million per year. The 105mm Howitzer is normally employed for indirect, unobserved fire for up to 80% of its targets. In possible 1970-75 conflicts, up to half of this could be targetted from large scale tactical maps, with the balance being used for harrassing and interdiction fire. If maps of the required ± 10-meter vertical accuracy are available for locating targets for unobserved 105mm Howitzer fire in such a future conflict of the present level of intensity, the increased effectiveness as compared with using maps having ± 40-meter vertical accuracy, can be valued at approximately $15 million per year.

The 155mm Howitzer is planned as the primary artillery weapon for fire support at ranges of 10 to 20 kilometers through the mid-1970's. For 155mm Howitzer battery fire against enemy troops in company-sized cantonments at these ranges, calculations show that approximately 25% more rounds are required for the same target coverage if the required 25-meter horizontal target location accuracy is relaxed to 50-meters. For the current level of intensity in Southeast Asia, 155mm Howitzer ammunition is being expended at a rate of more than 30 rounds per tube per day, also representing a cost of approximately $150 million per year. Thus, for this level of intensity and again assuming 80% unobserved fire, half of which is targetted from map data, the

Mapping Accuracy and Artillery Effectiveness (Cont'd)

degradation in 155mm Howitzer effectiveness can also be valued at approximately $15 million per year if the requirement for horizontal target location accuracy is relaxed from 25-meters to 50-meters.

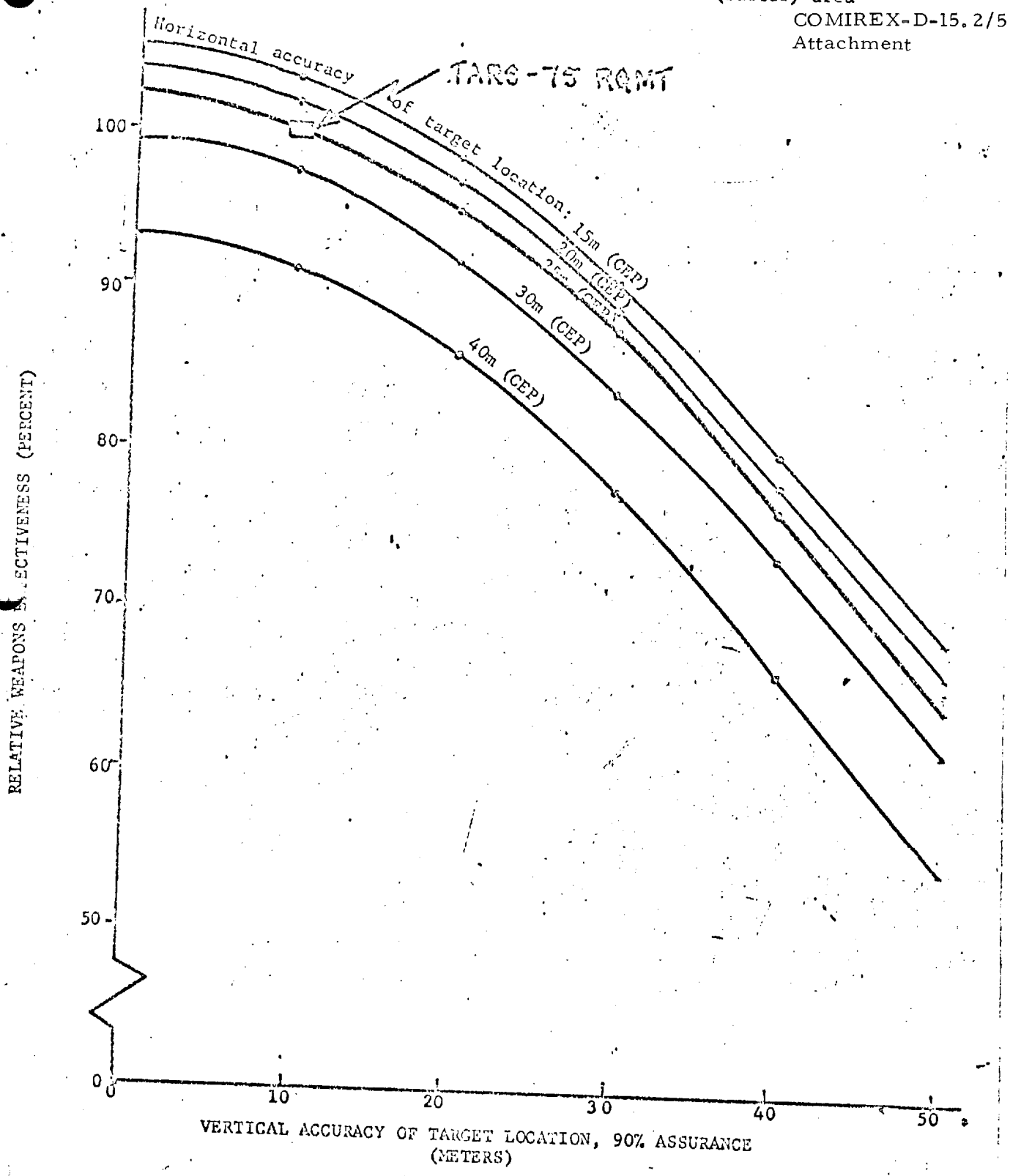
Over and above the dollar values cited, the advantage of surprise against enemy troops which can accrue from accurate, unobserved fire can be assigned a significant value in achieving the field commanders' objectives. Assuming that, on the average, half of the troops engaged by such fire will be caught in vulnerable postures (standing, as opposed to crouching in foxholes), the BRL data indicates a factor of 5 increased effectiveness for all such engagements. If a significant percentage of targets engaged are troops, say 50%, the overall effectiveness of a dollar spent on ammunition would at least be doubled. To achieve comparable levels of effect by increasing ammunition expenditures would cost 2 - 3 hundred million per year, for the example cited. The real savings are more difficult to quantify - since they lie in shortening the time required to "win". At Vietnamese expenditure rates, these savings are measured in billions of dollars per month. The cost of preparing the data bank from which adequately accurate maps can be prepared is less than 1 day's cost of the current war.

The importance of accurate military topographic maps is such that there is no doubt that an investment of $30 - $100 million to assure their prompt availability is amply justified. Attempts to fill the requirement with marginally adequate acquisition means would be to risk the necessity of doing the whole job over again.

Charles L. Poor
Deputy Assistant Secretary of the Army (R&D)

105mm HOWITZER @6km vs. Prone Personnel in 100m (radius) area

COMIREX-D-15.2/5
Attachment



MAPPING VERTICAL ACCURACY EFFECT ON 105mm HOWITZER

Weapon System
105mm Howitzer, M101A1
M1 Projectile, TNT loaded
Charge 5, 6km range, 29° angle of fall

Lethality against personnel:
Standing: 390 square meters
Prone: 330 square meters
Crouching in fox-holes: 40 square meters

Precision error: 28 meters (range)
4 meters (deflectio
Total predicted error: 39 meters (range)
(includes precision, met, etc) 17 meters (deflectio

Allowable target location error, per TARS-75: 25m (CEP)

Number of Rounds to Inflict 30% Casualties

	Target Radius (meters)	Vertical component of Target Location Error, 90% assurance ±0m	±10m	±20m	±30m	±40m	±50m
All Standing	50	55	56	59	66	73	82
	100	70	71	75	81	89	97
	200	152	153	156	161	168	176
All Prone	50	64	66	70	77	86	96
	100	82	84	88	96	104	114
	200	179	180	183	189	197	206
½ Prone and ½ Crouching in fox-holes	50	129	132	140	154	172	192
	100	166	168	176	191	208	229
	200	358	360	366	378	393	412
All Crouching in fox-holes	50	506	516	542	595	656	728
	100	656	665	691	739	800	872
	200	1448	1454	1467	1495	1529	1585

Inclosure 1

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Copy	1	DCI TCO for USIB/S
25X1	32	[redacted]
	33	DDP TCO
	34-36	CIA COMIREX Member
	37, 38	CIA MCGWG Member (TCO/Mag. Bldg)
	39, 40	C/ICRS
	41	Special Center TCO
	42	IRS Req Br/RecceGrp
	43	D/OSR
	44-53	Asst Ops/NPIC
	54	COMIREX Staff [redacted] 25X1
	55	Ch/EXRAND
	56	D/IAS
	57	TSO CIA
25X1	58	DDS&T [redacted]
	59	ASA/D/DCI/NIPE
	60	D/OSI
	61	ExSec, SORS/OSI
	62	D/OSP
	63	C/ILSS/DDS&T
	64	D/OEL
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	68	D/FMSAC
	69-73	SA(COMIREX)/DDI